

PART II - CUMULATIVE IMPACTS TO WILDLIFE IN SOUTHWEST WYOMING

A. INTRODUCTION

Cumulative impacts of the proposed Pinedale Anticline Oil and Gas Exploration and Development Project (PAPA) were examined within Cumulative Impact Analysis Areas (CIAA) that varied by species or species group. For reasons discussed in Part I, analyses focused on three species: pronghorn, mule deer and sage grouse. Cumulative impacts are defined as those that result from (CEQ, 1978; §1508.7):

"the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The principal focus of this section is on potential cumulative effects of oil and gas developments even though other Federal and/or non-Federal actions in each CIAA have undoubtedly impacted wildlife. These include urbanization, proliferation of roads, wildlife harvest, livestock grazing, and non-consumptive recreation in wildlife habitats.

The CEQ guidelines, though, do not provide guidance on the scope of geographic areas to be considered in cumulative impact analyses other than noting that projects may be evaluated with other actions in the same general location, such as body of water, region or metropolitan area (CEQ, 1978; §1502.4). In 1995, though, BLM initiated an evaluation of their land use and management practices in southwest Wyoming (BLM, 1999a), due in part to extensive oil and gas developments that have occurred in the past two decades as well as projected future developments (Table II.A-1 and Figure II.A-1). In keeping with ongoing interests in cumulative impacts of oil and gas projects in that part of the state, the analyses presented here include all or portions of southwest Wyoming.

B. CUMULATIVE IMPACT ANALYSIS AREAS

Pronghorn. The CIAA used to analyze cumulative impacts on pronghorn populations (Figure II.B-1) includes all of 7 Antelope Herd Units (Sublette, Uinta-Cedar Mountain, South Rock Springs, Bitter Creek, Carter Lease, Baggs, and Red Desert) in southwest Wyoming. In each Herd Unit, locations of oil and gas wells (BLM database) and roads (US Department of Commerce, TIGER coverage) were superimposed on seasonal ranges used by each pronghorn population. From these data, densities were computed for numbers of active wells and miles of road per square mile of crucial winter ranges, non-crucial winter ranges, and spring-summer-fall ranges developed in each herd unit.

Mule Deer. The CIAA used to analyze cumulative impacts on mule deer populations (Figure II.B-2) includes 7 Mule Deer Herd Units (Sublette, Wyoming Range, Uinta, South Rock Springs, Baggs, Steamboat and Chain Lakes) in southwest Wyoming. In each Herd Unit, locations of oil and gas wells and roads were superimposed on seasonal ranges using the same approach as discussed for pronghorn populations for evaluations of road and well pad density.

Sage Grouse. The CIAA used to analyze cumulative impacts on sage grouse (Figure II.B-3) includes 2 Upland and Small Game Management Areas (USGMAs) that include the PAPA, Area 3 (Sublette) and Area 7 (Eden). Known sage grouse leks in each USGMA were plotted from locations provided by WGFD with evaluations as active, inactive or unknown activity status during the past 5 years. Concentric circles with radii of 0.25 mile, 0.5 mile, 2 miles and 3 miles were generated around each lek location. Locations of oil and gas wells (BLM database) and roads (US Department of Commerce, TIGER coverage) were superimposed on leks and their concentric circles. Numbers of active wells and miles of road within radii of each concentric circle were computed for all leks.

C. LEVEL OF OIL AND GAS DEVELOPMENT

Pronghorn. Densities of active wells (number/square mile) and roads (miles of road/square mile) in crucial winter ranges (including crucial winter-yearlong, winter, and severe winter relief ranges), non-crucial winter ranges (including non-crucial yearlong, winter-yearlong, and winter ranges), and spring-summer-fall ranges were computed for each population. Those results are presented in Table II.C-1 along with lists of the oil and gas projects since 1984 that have been or are being developed in each herd unit.

Of all the pronghorn populations in southwest Wyoming, the Sublette Herd Unit has been impacted most by road proliferation in all occupied habitats, but especially in crucial winter ranges where road densities average more than 2 miles of road in each square mile of crucial winter habitat. Densities of active wells are also relatively high in all Sublette Herd Unit occupied ranges (Table II.C-1). Implementation of any of the alternatives presented for the PAPA will increase well and road densities in crucial and non-crucial winter ranges of the Sublette Antelope Herd Unit above densities shown in Table II.C-1. In addition, there are at least 2,305 oil or gas wells that could still be drilled in permitted project areas that overlap with the Sublette Antelope Herd Unit. Of these, 450 wells are likely to be drilled in the foreseeable future (Riley Ridge and Jonah II project areas) but would not occur within pronghorn crucial or non-crucial winter ranges in the Herd Unit.

The Carter Lease Antelope Herd Unit has been most impacted by wells with an average of 1 well per 1.7 square miles of crucial winter range and nearly 1 mile of road per every square mile of occupied habitat (Table II.C-1). That level of industry development occurred in the Whitney Canyon-Carter Lease fields prior to 1984 and was not evaluated by BLM's recent (1999b) Southwest Wyoming Resource Evaluation of oil and gas development in southwest Wyoming.

Mule Deer. The Wyoming Range Herd Unit has been impacted most by oil and gas wells and road proliferation, especially in crucial winter ranges where well densities average over 1 well per square mile and road densities average nearly 2 miles of road per square mile of crucial winter habitat. That level of industrial development occurred in the Whitney Canyon-Carter Lease fields prior to 1984 and was not evaluated by BLM's recent (1999b) Southwest Wyoming Resource Evaluation of Oil and Gas Development in Southwest Wyoming. Many additional wells could be drilled within the Wyoming Range Herd Unit in the foreseeable future: at least 702 wells in the Riley Ridge, Big Piney/LaBarge CAP area, East LaBarge Infill, Bird Canyon and Burley Field project have been allowed but not yet drilled. Also, portions of the Fontenelle and Moxa Arch projects overlap the herd unit and, together, 3,070 wells remain to be drilled in those areas.

Densities of wells on crucial winter ranges of the Sublette Herd Unit rank second to the Wyoming Range Herd Unit and densities of roads in both crucial and non-crucial winter ranges are substantial. The Steamboat herd unit also has high road densities in crucial and non-crucial winter ranges although well pad density is relatively low (Table II.C-2). Implementation of any of the alternatives presented for the PAPA will increase well and road densities in crucial and non-crucial winter ranges of the Sublette Mule Deer Herd Unit above densities shown in Table II.C-2. In addition, there are at least 1,539 oil or gas wells that could still be drilled in permitted project areas that overlap with the Sublette Mule Deer Herd Unit, principally in the Fontenelle, Jonah II Field, Stagecoach Draw and Soda Unit project areas. Of these, 321 wells are likely to be drilled in the foreseeable future (Jonah II Field project area) but not within mule deer crucial or non-crucial winter ranges in the Herd Unit.

Sage Grouse. Total number of well pads and miles of road within 0.25 mile, 0.50 mile, 2 miles and 3 miles of all documented sage leks in each of two Upland and Small Game Management Areas are presented in Table II.C-3 along with lists of the oil and gas projects since 1984 that have been or are being developed in USGMA. Clearly, many more wells in USGMA 3 are closer to leks (within 0.25-0.50 mile) than in USGMA 7. However, there are more miles of road between 2 and 3 miles of leks in USGMA 7 than USGMA 3.

Table II.A-1. Summary of Oil and Gas Development Projects Previously or Currently Being Analyzed Under NEPA in Southwest Wyoming as of December, 1998.

Project	Date ROD Signed	Number of Wells Existing When EIS Was Written	Number of Wells Allowed by ROD	Number of Wells Drilled Since ROD	Dry Hole, Depleted or Plugged & Abandoned	Completed but not Producing	Producing Wells	Remaining Wells that can still be Drilled (RFD) (1)
Riley Ridge	1/25/84	10	238	19	5	1	23	224
Burley	6/7/94	15	32	19	3	0	31	16
Jonah II Field	4/27/98	88	450	41	0	0	129	321
Coordinated Activity Plan Area	8/16/91	1,080	500	409	354	0	1,135	445
Soda Unit	4/12/89	4	17	0	1	0	3	18
Castle Creek	10/2/83	2	16	6	0	0	8	10
Moxa Arch	3/7/97	849	1,325	163	62	0	947	1,227
Hickey Mountain	5/13/87	16	70	19	9	10	26	50
Road Hollow	9/83	1	9	8	5	0	4	6
Fontenelle	8/16/96	907	1,292	151	6	6	1,052	1,141
Stagecoach	9/27/95	5	72	8	1	9	9	59
East LaBarge	5/29/92	83	28	19	1	83	19	9
Bird Canyon	6/25/93	6	14	6	0	6	6	8
Essex Mountain	8/4/95	0	3	0	0	0	0	3
Bravo Unit	7/20/95	3	10	6	1	2	7	4
Mulligan Draw	9/23/92	11	40	12	3	11	17	23
Creston Blue Gap	10/4/94	202	200	100	3	7	234	175
Dripping Rock / Cedar Break	4/3/85	11	58	20	2	11	24	34
Sierra Madre	9/21/87	16	46	27	2	16	30	16
Hay Reservoir	6/24/92	36	26	20	2	20	40	2
Jack Morrow Hills	pending	66	110 (3)	N/A	14	20	46	110
Continental Divide/Greater Wamsutter	pending	845	3,000 (3)	N/A	6	214	651	3,000
Pinedale Anticline	pending	41	700 (2)(3)	N/A	11	8	22	700
South Baggs	pending	17	90 (3)	N/A	13	1	16	90
Up. Green River - USFS MA 72	pending	23	17 (3)	N/A	23	0	0	10
Hoback Basin - USFS MA 21	pending	8	87 (3)	N/A	8	0	0	10
Total		4,345	4,446 (4)	1,053	535	424	4,479	7,711
notes: 1 = Reasonably foreseeable development that could take place within the next 10 to 15 years in southwest Wyoming. 2 = 700 pads, not wells 3 = No ROD available, pending completion of EIS's 4 = Total wells allowed for approved RODs. Total wells allowed including pending RODs = 8,450.								

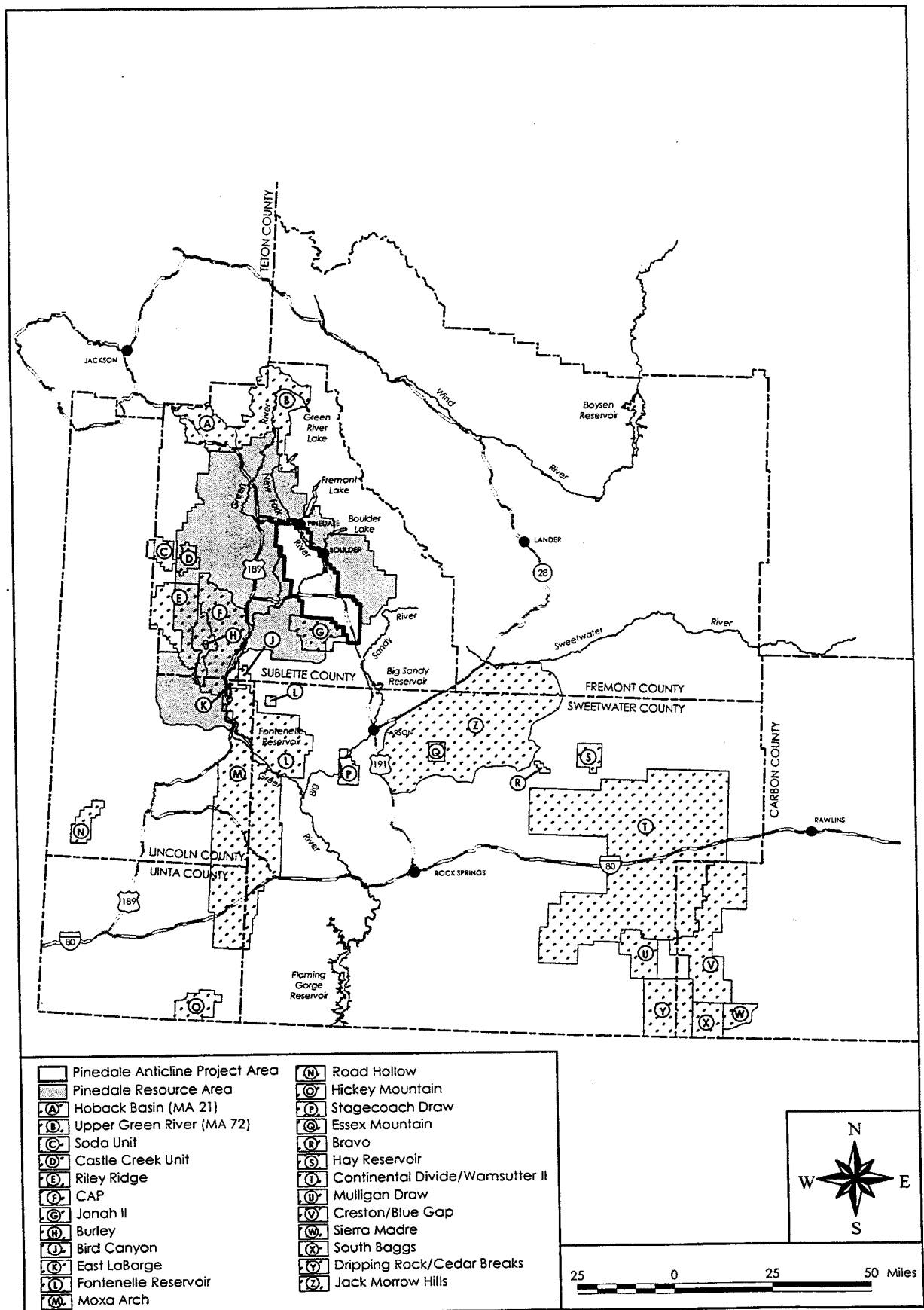


Figure II.A-1. Existing and Potential Oil and Gas Projects in Southwest Wyoming.

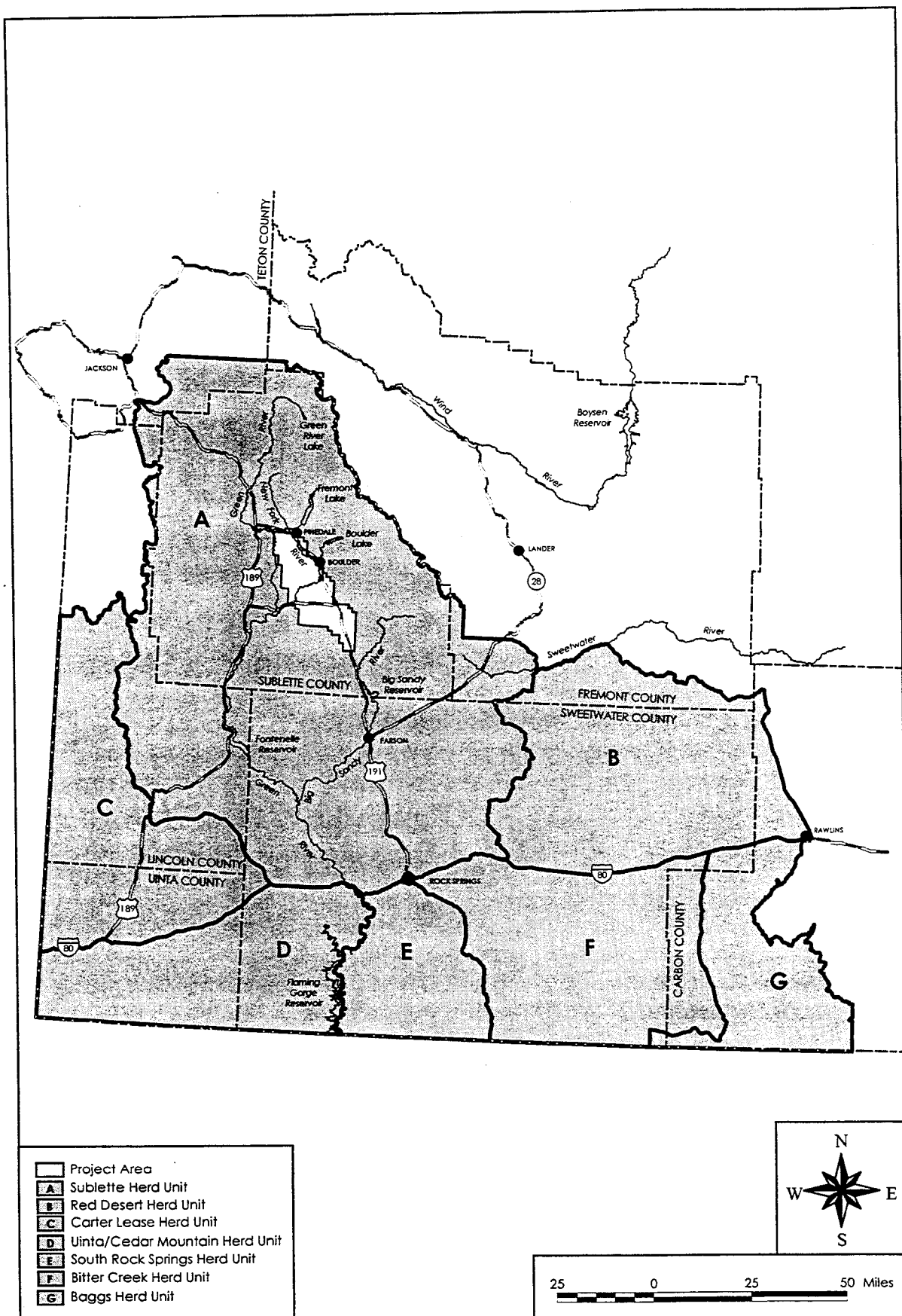


Figure II.B-1. Antelope Cumulative Impact Analysis Area.

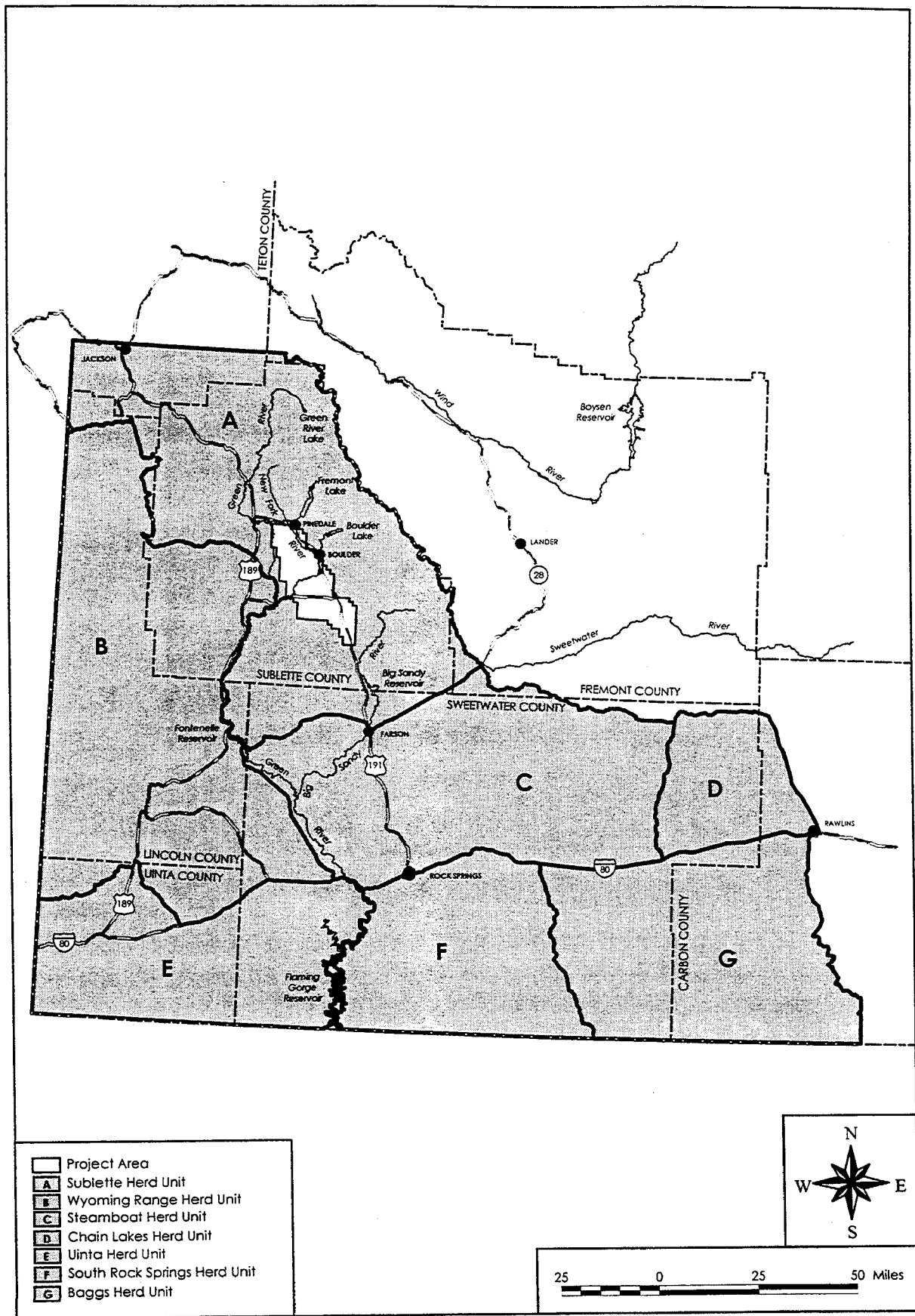


Figure II.B-2. Mule Deer Cumulative Impact Analysis Area.

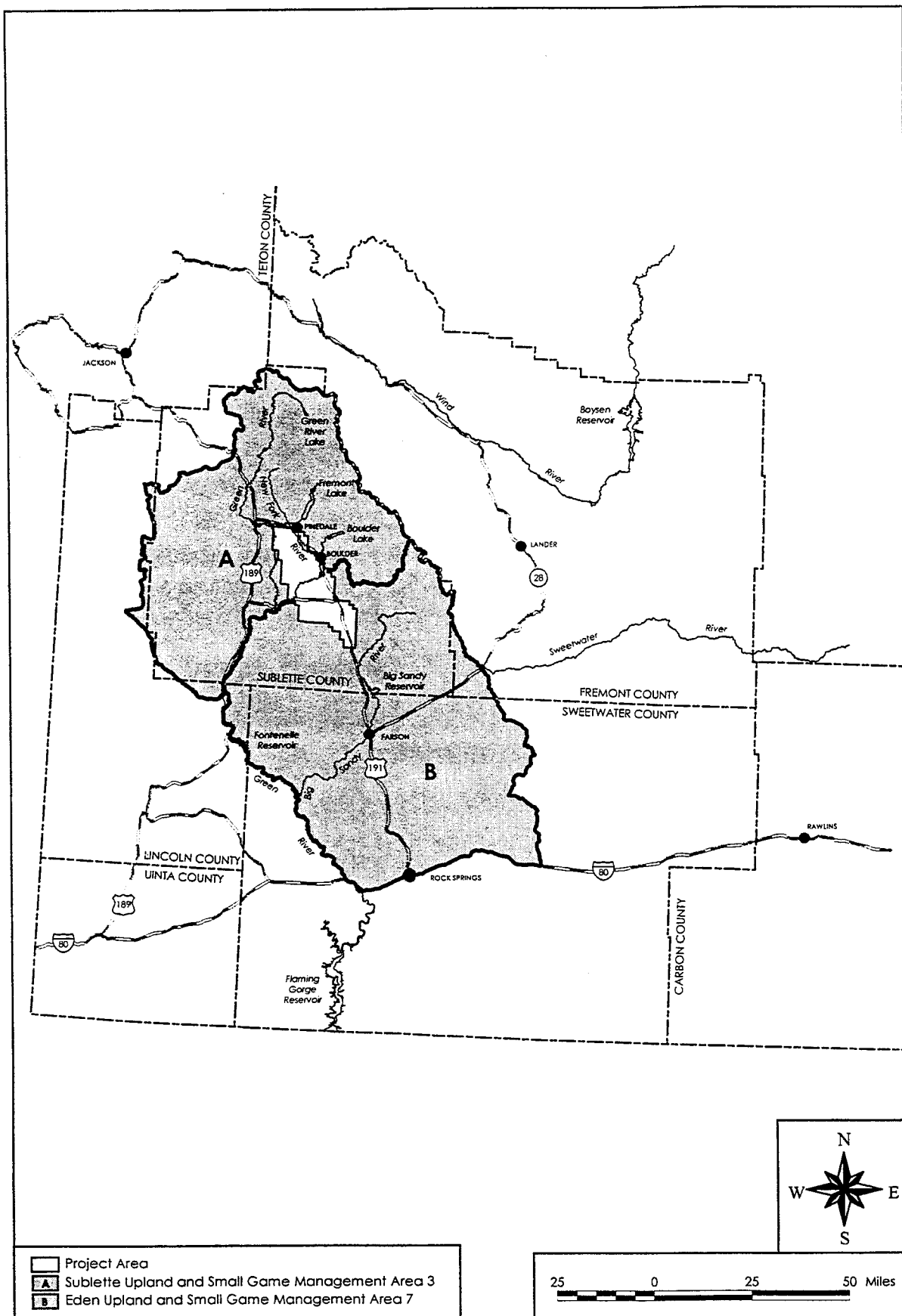


Figure II.B-3. Sage Grouse Cumulative Impact Analysis Area.

Table II.C-1. Oil and gas developments in southwest Wyoming since 1984 that coincide with seasonal ranges used by pronghorn in 7 Antelope Herd Units.

Antelope Herd Unit - Number	Oil/Gas Developments in Herd Unit with Year of NEPA Document (1)	Average Density of Active Oil/Gas Wells (2) and Roads (3) In Antelope Seasonal Habitats		
		Crucial Winter Ranges	Non-Crucial Winter Ranges	Spring-Summer-Fall Ranges
Sublette - 401	Riley Ridge - 1984 Soda Unit - 1988 Fontenelle II Infill - 1991 Big Piney/LaBarge CAP - 1991 East LaBarge Infill - 1992 Fontenelle II Infill - 1992 Bird Canyon - 1992 Mobil Project - 1994 Burley Field - 1994 Jonah Field - 1994 Stagecoach Draw - 1995 Moxa Arch Expansion - 1997 Fontenelle Infill - 1997 Jonah II - 1998	0.21 active wells/mi ² (1 well/4.8 mi ²) 2.02 miles of road/mi ² (1 mile/0.5 mi ²)	0.13 active wells/mi ² (1 well/7.6 mi ²) 1.82 miles of road/mi ² (1 mile/0.5 mi ²)	0.42 active wells/mi ² (1 well/2.4 mi ²) 1.52 miles of road/mi ² (1 mile/0.7 mi ²)
Uinta-Cedar Mtn - 411	Hickey/Table Mtn - 1987 Moxa Arch Expansion - 1997	0.00 active wells/mi ² 1.09 miles of road/mi ² (1 mile/0.9 mi ²)	0.09 active wells/mi ² (1 well/10.9 mi ²) 0.65 miles of road/mi ² (1 mile/1.5 mi ²)	0.07 active wells/mi ² (1 well/14.3 mi ²) 0.62 miles of road/mi ² (1 mile/1.6 mi ²)
South Rock Springs - 412	none	0.06 active wells/mi ² (1 well/17.9 mi ²) 1.56 miles of road/mi ² (1 mile/0.6 mi ²)	0.06 active wells/mi ² (1 well/16.4 mi ²) 1.55 miles of road/mi ² (1 mile/0.6 mi ²)	0.04 active wells/mi ² (1 well/23.3 mi ²) 1.43 miles of road/mi ² (1 mile/0.7 mi ²)
Bitter Creek - 414	Dripping Rock Unit-1985 Cedar Break Unit-1985 Mulligan Draw - 1992 Creston/Blue Gap - 1994 Greater Wamsutter Area II - 1995 Continental Divide/Wamsutter II - IP	0.25 active wells/mi ² (1 well/4.0 mi ²) 1.43 miles of road/mi ² (1 mile/0.7 mi ²)	0.29 active wells/mi ² (1 well/3.5 mi ²) 0.97 miles of road/mi ² (1 mile/1.0 mi ²)	0.00 active wells/mi ² 0.00 miles of road/mi ²

Table II.C-1. Oil and gas developments in southwest Wyoming since 1984 that coincide with seasonal ranges used by pronghorn in 7 Antelope Herd Units (continued).

Antelope Herd Unit - Number	Oil/Gas Developments in Herd Unit with Year of NEPA Document (1)	Average Density of Active Oil/Gas Wells (2) and Roads (3) In Antelope Seasonal Habitats		
		Crucial Winter Ranges	Non-Crucial Winter Ranges	Spring-Summer-Fall Ranges
Carter Lease - 419	Moxa Arch Expansion - 1997	0.58 active wells/mi ² (1 well/1.7 mi ²) 0.99 miles of road/mi ² (1 mile/1.0 mi ²)	0.06 active wells/mi ² (1 well/15.6 mi ²) 0.73 miles of road/mi ² (1 mile/1.4 mi ²)	0.26 active wells/mi ² (1 well/3.8 mi ²) 1.02 miles of road/mi ² (1 mile/1.0 mi ²)
Baggs - 438	Creston/Blue Gap - 1994 Continental Divide/Wamsutter II - <i>IP</i> South Baggs Area - <i>IP</i>	0.10 active wells/mi ² (1 well/10.4 mi ²) 0.03 miles of road/mi ² (1 mile/31.3 mi ²)	0.05 active wells/mi ² (1 well/21.7 mi ²) 0.56 miles of road/mi ² (1 mile/1.8 mi ²)	0.01 active wells/mi ² (1 well/90.9 mi ²) 0.00 miles of road/mi ²
Red Desert - 615	Hay Reservoir Unit - 1992 Greater Wamsutter Area - 1992 Creston/Blue Gap - 1994 Greater Wamsutter Area II - 1995 Essex Mountain - 1995 Bravo Unit - 1995 Continental Divide/Wamsutter II - <i>IP</i>	0.13 active wells/mi ² (1 well/7.6 mi ²) 0.93 miles of road/mi ² (1 mile/1.1 mi ²)	0.15 active wells/mi ² (1 well/6.5 mi ²) 1.20 miles of road/mi ² (1 mile/0.8 mi ²)	0.06 active wells/mi ² (1 well/16.9 mi ²) 1.30 miles of road/mi ² (1 mile/0.8 mi ²)
Notes: 1 = Data source from BLM, 1998: Southwest Wyoming Resource Evaluation Report and Recommendations. (<i>IP</i> indicates the NEPA document is in progress) 2 = BLM oil/gas well database overlaid on WGFD antelope seasonal range maps. 3 = Road database from US-Department of Commerce, TIGER coverage, including US highways, State and County roads, and BLM Resource Area roads, and some two-track field roads and overlaid on WGFD mule deer seasonal range maps.				

Table II.C-2. Oil and gas developments in southwest Wyoming since 1984 that coincide with seasonal ranges used by mule deer in 7 Mule Deer Herd Units.

Mule Deer Herd Unit - Number	Oil/Gas Developments in Herd Unit with Year of NEPA Document (1)	Average Density of Active Oil/Gas Wells (2) and Roads (3) In Mule Deer Seasonal Habitats		
		Crucial Winter Ranges	Non-Crucial Winter Ranges	Spring-Summer-Fall Ranges
Sublette - 104	Soda Unit - 1988 Jonah Field - 1994 Stagecoach Draw - 1995 Fontenelle Infill - 1997 Jonah II - 1998	0.36 active wells/mi ² (1 well/2.8 mi ²) 1.72 miles of road/mi ² (1 mile/0.6 mi ²)	0.03 active wells/mi ² (1 well/34.9 mi ²) 1.87 miles of road/mi ² (1 mile/0.5 mi ²)	0.003 active wells/mi ² (1 well/333.3 mi ²) 0.80 miles of road/mi ² (1 mile/1.3 mi ²)
Wyoming Range - 131	Riley Ridge - 1984 Fontenelle II Infill - 1991 Big Piney/LaBarge CAP - 1991 East LaBarge Infill - 1992 Fontenelle II Infill - 1992 Bird Canyon - 1992 Mobil Project - 1994 Burley Field - 1994 Moxa Arch Expansion - 1997 Fontenelle Infill - 1997	1.38 active wells/mi ² (1 well/0.7 mi ²) 1.84 miles of road/mi ² (1 mile/0.5 mi ²)	0.30 active wells/mi ² (1 well/3.3 mi ²) 1.67 miles of road/mi ² (1 mile/0.6 mi ²)	0.04 active wells/mi ² (1 well/24.4 mi ²) 0.93 miles of road/mi ² (1 mile/0.9 mi ²)
Uinta - 423	Hickey/Table Mtn - 1987 Moxa Arch Expansion - 1997	0.03 active wells/mi ² (1 well/29.4 mi ²) 0.57 miles of road/mi ² (1 mile/1.7 mi ²)	0.03 active wells/mi ² (1 well/30.3 mi ²) 0.29 miles of road/mi ² (1 mile/3.4 mi ²)	0.14 active wells/mi ² (1 well/7.2 mi ²) 0.00 miles of road/mi ²
South Rock Springs - 424	none	0.01 active wells/mi ² (1 well/111.1 mi ²) 0.00 miles of road/mi ²	0.10 active wells/mi ² (1 well/9.6 mi ²) 1.36 miles of road/mi ² (1 mile/0.7 mi ²)	0.06 active wells/mi ² (1 well/17.2 mi ²) 1.47 miles of road/mi ² (1 mile/0.7 mi ²)
Baggs - 427	Dripping Rock Unit-1985 Cedar Break Unit-1985 Mulligan Draw - 1992 Greater Wamsutter Area - 1992 Creston/Blue Gap - 1994 Greater Wamsutter Area II - 1995 Continental Divide/Wamsutter II - IP South Baggs Area - IP	0.21 active wells/mi ² (1 well/4.9 mi ²) 0.33 miles of road/mi ² (1 mile/3.0 mi ²)	0.32 active wells/mi ² (1 well/3.1 mi ²) 0.68 miles of road/mi ² (1 mile/1.5 mi ²)	0.01 active wells/mi ² (1 well/142.9 mi ²) 0.93 miles of road/mi ² (1 mile/142.9 mi ²)

Table II.C-2. Oil and gas developments in southwest Wyoming since 1984 that coincide with seasonal ranges used by mule deer in 7 Mule Deer Herd Units (continued).

Mule Deer Herd Unit - Number	Oil/Gas Developments in Herd Unit with Year of NEPA Document (1)	Average Density of Active Oil/Gas Wells (2) and Roads (3) In Mule Deer Seasonal Habitats		
		Crucial Winter Ranges	Non-Crucial Winter Ranges	Spring-Summer-Fall Ranges
Steamboat - 430	Hay Reservoir Unit - 1992 Greater Wamsutter Area - 1992 Creston/Blue Gap - 1994 Stagecoach Draw - 1995 Greater Wamsutter Area II - 1995 Essex Mountain - 1995 Bravo Unit - 1995 Continental Divide/Wamsutter II - <i>IP</i>	0.14 active wells/mi ² (1 well/7.2 mi ²) 1.75 miles of road/mi ² (1 mile/0.6 mi ²)	0.08 active wells/mi ² (1 well/12.1 mi ²) 1.71 miles of road/mi ² (1 mile/0.6 mi ²)	0.22 active wells/mi ² (1 well/4.6 mi ²) 1.44 miles of road/mi ² (1 mile/0.7 mi ²)
Chain Lakes - 650	Greater Wamsutter Area - 1992 Greater Wamsutter Area II - 1995 Continental Divide/Wamsutter II - <i>IP</i>	0.00 active wells/mi ² 0.00 miles of road/mi ²	0.03 active wells/mi ² (1 well/37.3 mi ²) 1.03 miles of road/mi ² (1 mile/1.0 mi ²)	0.000 active wells/mi ² 0.00 miles of road/mi ²
<p>Notes:</p> <p>1 = Data source from BLM, 1998: Southwest Wyoming Resource Evaluation Report and Recommendations. (<i>IP</i> indicates the NEPA document is in progress)</p> <p>2 = BLM oil/gas well database overlaid on WGFD mule deer seasonal range maps.</p> <p>3 = Road database from US-Department of Commerce, TIGER coverage, including US highways, State and County roads, and BLM Resource Area roads, and some two-track field roads and overlaid on WGFD mule deer seasonal range maps.</p>				

Table II.C-3. Oil and gas developments in southwest Wyoming since 1984 that coincide with sage grouse lek locations in 2 Upland and Small Game Management Areas (USGMA).

Upland and Small Game Management Area - Number	Oil/Gas Developments in USGMA with Year of NEPA Document (1)	Total Number of Oil/Gas Wells (2) and Miles of Roads (3) Within Distances of Sage Grouse Leks			
		Within 0.25 mile	Within 0.50 mile	Within 2.0 mile	Within 3.0 mile
Sublette - USGMA 3	Riley Ridge - 1984 Soda Unit - 1988 Fontenelle II Infill - 1991 Big Piney/LaBarge CAP - 1991 East LaBarge Infill - 1992 Fontenelle II Infill - 1992 Bird Canyon - 1992 Mobil Project - 1994 Burley Field - 1994 Fontenelle Infill - 1997	21 wells 53.9 miles of road	75 wells 168.8 miles of road	916 wells 1,336.9 miles of road	1,280 wells 1,988.5 miles of road
Eden - USGMA 7	Jonah Field - 1994 Stagecoach Draw - 1995 Fontenelle Infill - 1997 Jonah II - 1998	2 wells 55.6 miles of road	6 wells 190.2 miles of road	112 wells 1,872.3 miles of road	212 wells 3,067.8 miles of road
Notes: 1 = Data source from BLM, 1998: Southwest Wyoming Resource Evaluation Report and Recommendations. 2 = BLM oil/gas well database overlaid on sage grouse lek location maps. 3 = Road database from US-Department of Commerce, TIGER coverage, including US highways, State and County roads, and BLM Resource Area roads, and some two-track field roads and overlaid on sage grouse lek location maps.					

D. POSSIBLE EFFECTS ON POPULATION PARAMETERS - ANALYSIS

Big Game. Two parameters related to population growth were developed for analysis of pronghorn and mule deer populations in southwest Wyoming. These include estimates of fawn productivity rates for reproducing-age females and maximum survival rates for fawns age 4-6 months to 16-18 months old (survival rate from before their first winter until before the start of their second winter). These parameters utilize data collected by WGFD annually during pre-harvest (pronghorn) and post-harvest (mule deer) herd composition surveys.

Actual numbers of adult males, yearling males, females (including yearlings and adults) and fawns counted within each hunt area during post-season composition surveys are provided in WGFD annual herd unit reports. To estimate fawn productivity for only reproducing-age females, pre- or post-season counts of all does must be adjusted by subtracting the estimated numbers of yearling females. Once done, the ratio of fawns:does provides production rates of fawns at age 4-6 months by mature does, 2 years and older. However, yearling does can not be distinguished from mature does during pre- or post-season composition surveys but yearling bucks usually are classified. If one assumes 1) that sex ratios of fawns are equal, 2) harvest of yearling bucks and/or yearling does not affect their occurrences in herd composition surveys (i.e., the population and hence the post-season sample), and 3) that the probability of counting yearling does is the same as counting yearling bucks during the surveys, then the number of mature does (2 years and older) is estimated by subtracting the number of yearling bucks counted from the total number of does counted. The number of adult (reproducing) females is then $n_{af} = n_d - n_{ym}$, and the adjusted productivity rate of fawns per doe 2 years and older is (n_f / n_{af}) , where

number of yearling males counted: n_{ym}
number of all females (does) counted: n_d
number of fawns counted: n_f

Recent investigations (Unsworth *et al.*, 1999) show that the sex ratio of mule deer fawns is approximately 50:50 in early winter. While this supports assumption #1, above the researchers found that female fawns tend to have slightly higher overwinter survival than male fawns. Consequently, subtracting n_{ym} from n_d to will overestimate n_{af} in some years thus underestimating the productivity rate.

Estimation of the maximum survival rate for pronghorn and mule deer during the interval from 4-6 months old (before they enter their first winter) to 16-18 months (before entering their second winter) is possible once two ratios are known: fawns:adult does (4 or 6-month old fawns:does 2+ years) and total yearlings:adult does (14 or 18-month old deer:does 2+ years). That maximum survival rate (assuming no adult doe mortality during the 1-year interval) is expected to be directly related to winter precipitation, November through March, during the 1-year interval including fawns' first winter. The maximum survival rate should be indicative of population growth potential, since the yearling cohort will be entering the populations' reproductive class during the next year.

Details of the procedure used to estimate maximum fawn survival rates are provided in Appendix B and are modified from White *et al.* (1996). Briefly, two ratios can be calculated from pre- or post-harvest composition surveys:

Ratio A: numbers of fawn counted/number of adult does counted during pre- or post-season surveys in year 1

$$A = n_f / n_{af}$$

Ratio B: number of yearlings counted/number of adult does counted during pre- or post-season surveys in year 2

$$B = (2 \times n_{ym}) / n_{af}$$

Since the number of yearling females included in the number of all females counted post-season is assumed to equal the number of yearling males counted, the count of yearling males, n_{ym} , is doubled to approximate the total number of yearlings in the pre- or post-season count in the second year. The maximum fawn survival rate is $S_{f-max} = B / A$ (see Appendix B and White *et al.*, 1996).

For mule deer, fawn and adult mortality rates over winter are directly related to total winter precipitation, November through March. Increase of fawn mortality rates with increasing precipitation is greater than for adult

mortality rates. Data collected in the Sublette Herd Unit (McWhirter, 1999) clearly show this trend (Figure II.D-1). Since winter 1992-1993, WGFD has collected data on mule deer wintering on the PAPA and vicinity that allow calculation of fawn and adult mule deer mortality rates over winter. Those data include counts of fawns and adults before winter (November), counts of fawns and adults after winter (April), and counts of fawn and adult deer carcasses in April (McWhirter, 1999). Using techniques developed by White *et al.* (1996), these empirical data provide estimates of fawn and adult mortality from winters 1992-1993 through 1997-1998 and show a strong relationship to winter precipitation data measured by NOAA cooperators in Pinedale. As total winter precipitation (November through March) increases, so do fawn and adult mortality rates. In fact, winter precipitation explains 84 percent of the observed variation in fawn mortality rates and 61 percent of the variation in adult deer mortality rate. Not surprisingly, fawn mortality increases at a greater rate than adult mortality with increasing winter precipitation. Because of this relationship, winter precipitation was compiled for each mule deer and antelope herd unit in southwest Wyoming as total inches of water, November through March for each winter 1977 through 1998. Data reported by National Weather Service, NOAA cooperators at locations nearest pronghorn and mule deer winter ranges were averaged for each month if there was more than one station reporting.

Sage Grouse. Sage grouse lek locations and activity data were provided by WGFD biologists in Pinedale and Green River for leks in the Sublette and Eden USGMAs. The two areas cover most of Sublette County and portions of Sweetwater, Lincoln and Fremont counties (Figure II.B-3). Leks were identified as active, inactive or unknown activity status based on WGFD surveys over the past 5 years. The most recent lek activity status in that period was assigned. For example, if a lek had been surveyed just once in that period, was found to be active but not surveyed since, it was assigned an active status. But if there were no surveys conducted over the past 5 years, the lek's status was unknown.

Mule Deer Fawn & Adult Mortality Rates Sublette Herd Unit, Winters 1992-1998

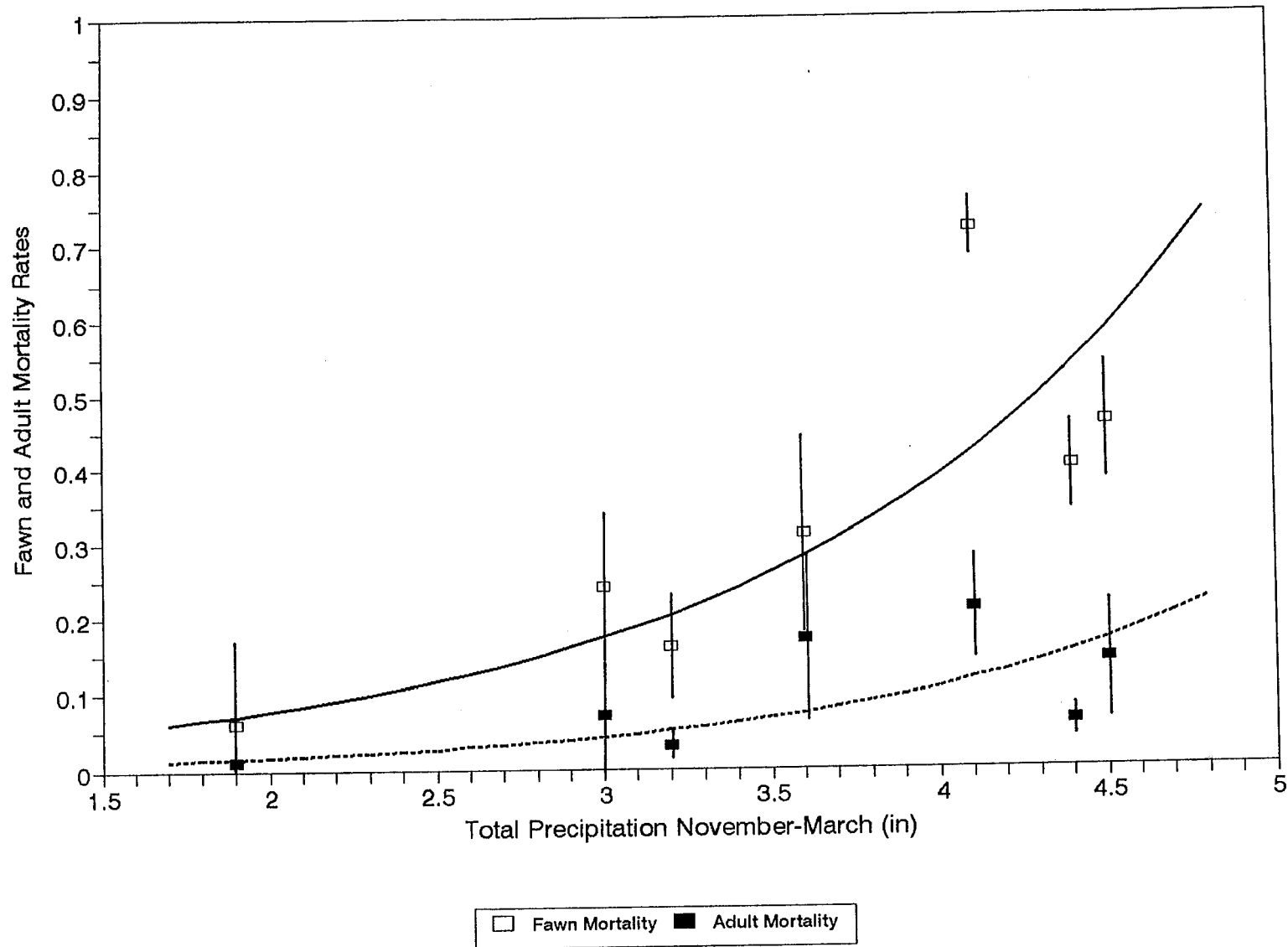


Figure II.D-1. Relationship of overwinter fawn and adult mule deer mortality rates as nonlinear functions of total winter precipitation, November through March, since 1992 in the Sublette Mule Deer Herd Unit. The relationship of winter precipitation to fawn mortality rate is significant ($r^2 = 0.84$, $p = 0.004$) as is the relationship to adult mortality rate ($r^2 = 0.61$, $p = 0.038$). Brackets are 90% confidence intervals on each estimate. Winter precipitation data were averaged for NOAA cooperators at Pinedale, Daniel Fish Hatchery, and Boulder Rearing Station.

E. POSSIBLE EFFECTS ON POPULATION PARAMETERS - RESULTS

Pronghorn. Possible effects of major oil and gas projects on pronghorn population parameters that contribute to population growth were examined from pre-harvest herd composition survey field data collected by WGFD in all 7 herd units since 1978. Those data were used to compute fawn production rates (numbers of fawns per female 2+ years old) and maximum fawn survival between age 4 months to 16 months with analytical techniques described above. Trends in productivity rates and survival rates over time for each herd unit are provided in Appendix C.

Data summaries are presented (Table II.E-1) for two time periods: the first is from 1979 until the year prior to implementation of the first major (100 wells or more authorized) oil or gas project in the herd unit; the second period analyzed is one year after BLM's record of decision for that first major project through 1998. Analyses of pronghorn fawn production rates show diminished productivity in all herd units subject to increased oil/gas developments since the early 1990's. Maximum fawn survival rates, though, are mostly unchanged from before to after implementation of major projects. The data do not conclusively identify decreased fawn production as a result of oil/gas developments within affected herd units.

There are other factors influencing fawn productivity as well, winter precipitation may play a role, but also population size (density-dependent reproduction), availability and nutritional value of forage, availability of water and competition with other herbivores. Winter precipitation, though, can play a major role in pronghorn population growth, both in terms of fawn production after winter and fawn survival through the winter.

Winter precipitation was compiled for each Antelope Herd Unit as total inches of water, November through March for each winter 1978 through 1998. Data reported by NOAA cooperators at locations nearest pronghorn winter ranges were averaged for each month if there was more than one station reporting. Trends in total winter precipitation, fawn production and survival estimates over time are included in Appendix C. The winter of 1983-84 was considered to be a severe winter with precipitation well above 1961-1990 averages (Wyoming Water Resources Data System database). Pronghorn fawn production rates following that winter and fawn maximum survival rates in the 1-year period that included that winter are provided in Table II.E-2 for each herd unit, as well as the total winter precipitation. For unknown reasons, fawn production and survival rates in the South Rock Springs Herd Unit in following winter 1983-84 were above average rates for 1979-1998 (Table II.E-1) but fawn production and survival rates in all other populations after that winter were well below averages.

During the 1990's, there were winters after which fawn production rates were even lower than those following winter 1983-84 but total winter precipitation was markedly less than that extreme winter (Table II.E-2). Two exceptions, Uinta-Cedar Mountain and South Rock Springs herd units, suffered dramatically lower fawn production during winter 1992-93 which produced more precipitation than winter 1983-84. Coincidentally, of all herd units these two have the lowest density of active wells on crucial and non-crucial winter ranges. Lowest fawn production rates in the other 4 herd units during the 1990's were below rates determined following winter 1983-84 but occurred in years with much lower winter precipitation than that severe winter (Table II.E-2). Though not as consistent, a similar pattern is present in comparisons of fawn survival rates during winter 1983-84 and winters during the 1990's.

These observations raise more questions than they answer. Estimates of pronghorn populations were quite large during the late 1980's and early 1990's and WGFD managed harvests to reduce the populations by including substantial harvest of females and juveniles. Following the winter of 1983-84 there were several years of below average winter, spring and summer precipitation that undoubtedly allowed for increased survival and population growth but probably had adverse effects on vegetation succulence, abundance and nutrition. Too, oil and gas projects proliferated near the end of that time, during the early 1990's. During the winter of 1992-93 for some herd units, winter 1994-95 for others, most populations suffered much lower fawn production and lower survival with relatively lower winter precipitation than expected given similar effects following the severe winter of 1983-84. For whatever reason(s), it appears that habitat functions of crucial and non-crucial winter ranges in these herd units has been diminished since the early 1980's. The situation warrants much closer investigation before cumulative effects due to oil and gas developments and other land uses on pronghorn populations can be predicted.

Table II.E-1. Pronghorn population parameters in southwest Wyoming herd units before and 1 year after major oil/gas project NEPA decision documents were issued by BLM for projects coinciding with each herd unit. Fawn production rate (number of fawns divided by number of does 2 years or older counted pre-harvest, before the hunting season) and maximum fawn survival rate (estimated for the period from age 4 months to age 16 months) were averaged for the time periods shown (with standard errors, SE).

Antelope Herd Unit - Number	Year After Major NEPA Document (1)	Fawn Production \pm SE (fawns/doe 2+ years old)				Maximum Fawn Survival Rate \pm SE (age 4 to 16 months)			
		Period	Mean \pm SE	Period	Mean \pm SE	Period	Mean \pm SE	Period	Mean \pm SE
Sublette - 401	1992	1979-1991	0.95 \pm 0.04	1992-1998	0.77 \pm 0.05	1979-1991	0.52 \pm 0.04	1992-1998	0.53 \pm 0.02
Uinta-Cedar Mtn - 411	1998	1979-1997	0.71 \pm 0.05	1998	0.66	1979-1997	0.52 \pm 0.04	1998	0.70
South Rock Springs - 412	none	1979-1998	0.65 \pm 0.06	none	-	1979-1998	0.57 \pm 0.03	none	-
Bitter Creek - 414	1993	1979-1992	0.76 \pm 0.06	1993-1998	0.55 \pm 0.03	1979-1992	0.57 \pm 0.05	1993-1998	0.44 \pm 0.05
Carter Lease - 419	1998	1979-1997	0.96 \pm 0.06	1998	1.10	1979-1997	0.52 \pm 0.03	1998	0.56
Baggs -438	1995	1979-1994	0.83 \pm 0.06	1995-1998	0.45 \pm 0.07	1979-1994	0.58 \pm 0.05	1995-1998	0.62 \pm 0.12
Red Desert - 615	1993	1979-1992	0.89 \pm 0.06	1993-1998	0.63 \pm 0.03	1979-1992	0.49 \pm 0.05	1993-1998	0.45 \pm 0.04
Note: 1 =Major NEPA documents are those authorizing projects with 100 wells or more.									

Table II.E-2. Comparisons of total winter precipitation, pronghorn fawn production rates and survival rates in 7 Antelope Herd Units during the severe winter of 1983-84 and winters of the 1990's with lowest fawn production and/or survival rate estimates.

Antelope Herd Unit- Number	Winter 1983-1984			Winter During 1990's with Lowest Fawn Production and/or Survival			
	Total Winter (1) Precipitation	Fawn Production Rate After Winter	Fawn Maximum Survival Rate Through Winter	Winter	Total Winter (1) Precipitation	Fawn Production Rate After Winter	Fawn Maximum Survival Rate Through Winter
Sublette - 401	3.36	0.699	0.259	1991-92	2.22	0.567	0.521
Uinta-Cedar Mtn - 411	3.62	0.579	0.452	1992-93	4.11	0.315	0.299
South Rock Springs - 412	3.18	0.873	0.613	1992-93	3.46	0.277	0.718
Bitter Creek - 414	4.26	0.529	0.303	1994-95	2.71	0.495	0.322
Carter Lease - 419	4.84	0.693	0.413	1992-93	3.95	0.289	0.322
Baggs - 438	5.52	0.509	0.069	1994-95	2.08	0.294	0.274
Red Desert - 615	3.76	0.716	0.168	1994-95	2.59	0.517	0.349
Note: 1 =Total winter precipitation as inches of water includes data from November through March and averaged for 2 or more NOAA weather stations within or near winter ranges in each herd unit.							

Mule Deer. Similar to analyses discussed for pronghorn populations, possible effects of major oil and gas projects on mule deer population parameters were examined from post-harvest herd composition survey field data collected by WGFD in 6 of the 7 herd units since the late 1970's to mid-1980's. Insufficient herd composition data exists for the Chain Lakes Herd Unit for it to be included in these analyses. As with pronghorn, these data were used to compute fawn production rates and maximum fawn survival rates. Trends in these rates over time for each herd unit are provided in Appendix D.

Results of these analyses are summarized in Table II.E-3 for two time periods: the first is from 1979 or whenever suitable data collection began until the year prior to implementation of the first major (100 wells or more authorized) oil/gas project in the herd unit; the second period analyzed is one year after BLM's record of decision for that first major project through 1998. Analyses of mule deer fawn production rates in 4 herd units show slightly diminished productivity in 3 of them following increased oil/gas developments. Maximum fawn survival rates are mostly unchanged from before to after implementation of major projects.

As in Section D, winter precipitation is a major influence on pronghorn winter survival, especially for fawns. Winter precipitation was compiled for each Mule Deer Herd Unit as total inches of water, November through March for each winter 1977 through 1998. Data reported by NOAA cooperators at locations nearest mule deer winter ranges were averaged for each month if there was more than one station reporting. The winter of 1983-84 was considered to be an extremely severe winter with precipitation well above 1961-1990 averages (Wyoming Water Resources Data System database). Mule deer fawn production rates following that winter and fawn maximum survival rates are provided in Table II.E-4 for each herd unit in which sufficient data were collected. Total winter precipitation for winter 1983-84 is also given.

Fawn production rates following winter 1983-84 in the 4 populations for which data were available were near or somewhat below averages shown in Table II.E-3 while fawn survival rates through that winter were far below averages in the three herd units for which data was collected that year. During the 1990's, there were winters after which fawn production rates were even lower than those determined following winter 1983-84 but total winter precipitation was less than during that extreme winter (Table II.E-4). Lowest fawn production rates in 4 herd units analyzed during the 1990's was below rates determined following winter 1983-84 but occurred in years with less winter precipitation than in 1983-84 (Table II.E-4). A similar pattern is present in comparisons of fawn survival rates during winter 1983-84 and winters during the 1990's.

In addition, linear regression analyses were performed with maximum fawn survival (as the dependent variable) regressed against total winter precipitation (as the independent variable) in all years for which data were available. Significant relationships (with $p < 0.05$) were found only in analyses conducted on the Sublette and Wyoming Range herd units: as total winter precipitation increased, maximum fawn survival decreased. In both herd units, an especially interesting relationship was found in which the rate of decrease (slope of the regression equation) for fawn survival with increasing precipitation was significantly greater with data collected between 1995 and 1998 than with data collected before 1995. That is, fawn survival rates as a function of winter precipitation have been less since 1995 than expectations based on survival rates and precipitation observed before 1995 (Figure II.E-1). No similar relationships were found in any other mule deer population.

Similar to analyses conducted for pronghorn and for similar reasons, these observations raise more questions than they answer. Estimates of mule deer populations were quite large during the late 1980's and early 1990's and efforts to reduce the populations were made through substantial harvest of females and juveniles. Winters from the mid-1980's through the early 1990's were relatively mild with low precipitation that undoubtedly allowed for increased fawn survival and population growth. Too, oil and gas projects proliferated near the end of that time, during the early 1990's. During the winter of 1992-93 the 4 mule deer populations analyzed suffered lower fawn production and lower fawn survival with relatively lower winter precipitation than would have been expected given similar effects following the severe winter of 1983-84. Those parameters could also have been influenced by population size (density-dependent reproduction), availability and nutritional value of forage, availability of water and competition with other herbivores. For whatever reason(s), habitat functions of crucial and non-crucial winter ranges in these mule deer herd units do not appear to be as effective as they were in the early 1980's.

Table II.E-3. Mule deer population parameters in southwest Wyoming herd units before and 1 year after major oil/gas project NEPA decision documents were issued by BLM for projects coinciding with each herd unit. Fawn production rate (number of fawns divided by number of does 2 years or older counted post-harvest, after the hunting season) and maximum fawn survival rate (estimated for the period from age 6 months to age 18 months) were averaged for the time periods shown (with standard errors, SE).

Mule Deer Herd Unit- Number	Year After Major NEPA Document (1)	Fawn Production \pm SE (fawns/doe 2+ years old)				Maximum Fawn Survival Rate \pm SE (age 6 to 18 months)			
		Period	Mean \pm SE	Period	Mean \pm SE	Period	Mean \pm SE	Period	Mean \pm SE
Sublette - 104	1995	1979-1994	0.85 \pm 0.03	1995-1998	0.82 \pm 0.04	1979-1994	0.40 \pm 0.03	1995-1998	0.36 \pm 0.05
Wyoming Range - 131	1992	1979-1991	0.89 \pm 0.03	1992-1998	0.74 \pm 0.06	1979-1991	0.31 \pm 0.04	1992-1998	0.37 \pm 0.05
Uinta - 423	1998	1986-1997	0.77 \pm 0.05	1998	0.88	1986-1997	0.33 \pm 0.04	1998	0.22
South Rock Springs - 424	none	1982-1998	0.68 \pm 0.03	none	-	1982-1998	0.23 \pm 0.02	none	-
Baggs - 427	1993	1979-1992	0.94 \pm 0.06	1993-1998	0.71 \pm 0.05	1979-1992	0.30 \pm 0.03	1993-1998	0.31 \pm 0.06
Steamboat - 430	1993	1979-1992	0.79 \pm 0.05	1993-1998	0.82 \pm 0.11	1979-1992	0.36 \pm 0.04	1993-1998	0.38 \pm 0.10
Chain Lakes - 650	1993	no data	-	no data	-	no data	-	no data	-

Note: 1 =Major NEPA documents are those authorizing projects with 100 wells or more.

Table II.E-4. Comparisons of total winter precipitation, mule deer fawn production rates and survival rates in 6 Mule Deer Herd Units (no data was collected in the Chain Lakes Herd Unit) during the severe winter of 1983-84 and winters of the 1990's with lowest fawn production and survival rate estimates.

Mule Deer Herd Unit- Number	Winter 1983-1984			Winter During 1990's with Lowest Fawn Production and Survival			
	Total Winter (1) Precipitation	Fawn Production Rate After Winter	Fawn Maximum Survival Rate Through Winter	Winter	Total Winter (1) Precipitation	Fawn Production Rate After Winter	Fawn Maximum Survival Rate Through Winter
Sublette - 104	3.64	0.820	0.210	1992-93	2.84	0.539	0.219
Wyoming Range - 131	4.82	0.747	0.059	1992-93	3.88	0.509	0.148
Uinta - 423	3.16	no data	no data	1992-93	3.83	0.432	0.077
South Rock Springs - 424	3.44	0.526	0.098	1991-92	3.20	0.479	0.198
Baggs - 427	4.71	no data	no data	1992-93	2.47	0.522	0.060
Steamboat - 430	3.22	0.600	no data	1992-93	3.16	0.434	0.109

Note: 1 =Total winter precipitation as inches of water includes data from November through March and averaged for 2 or more NOAA weather stations within or near winter ranges in the herd unit.

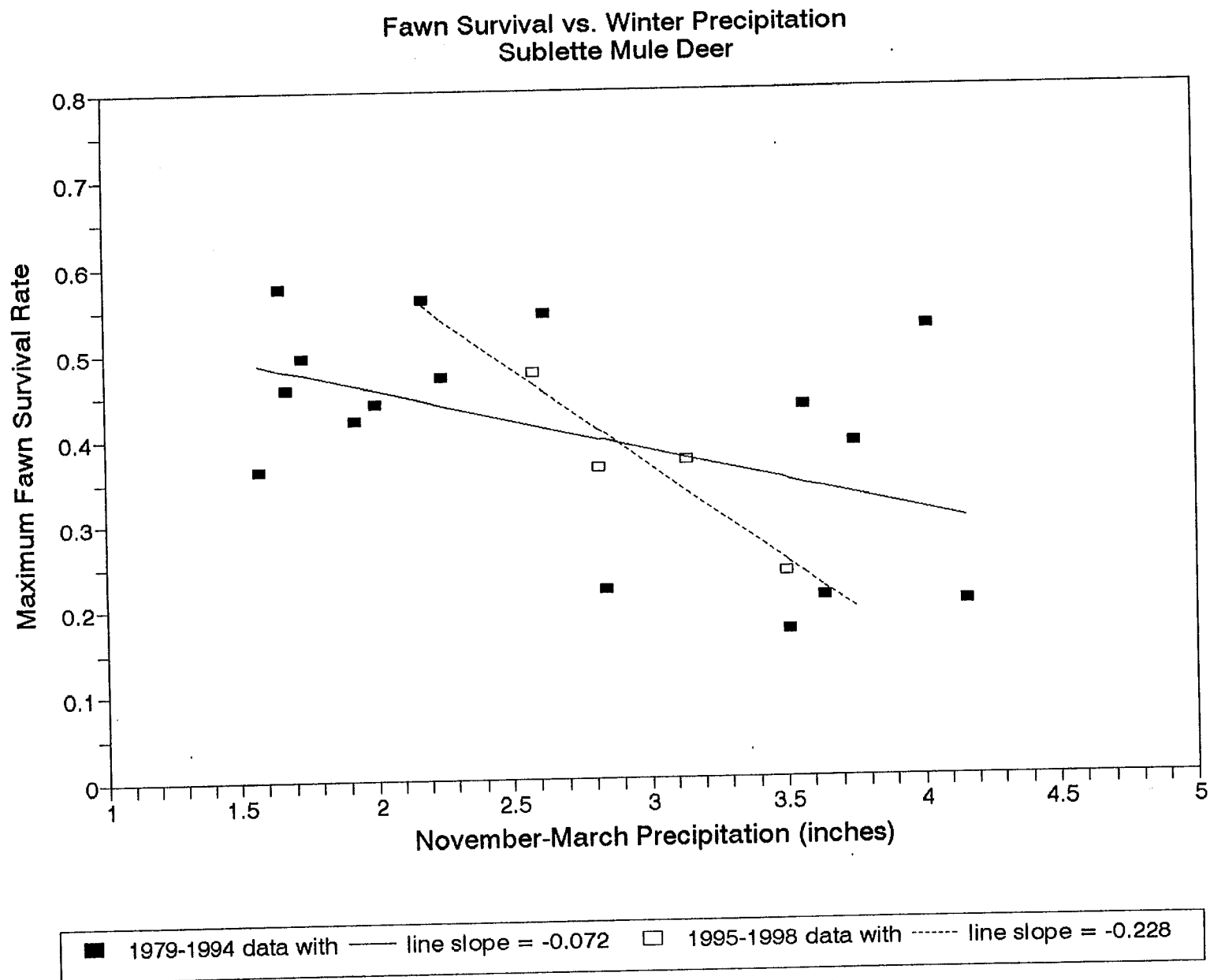


Figure II.E-1. Maximum fawn survival rates in the Sublette Mule Deer Herd Unit decrease slightly with increasing winter precipitation from 1979 to 1994 (solid line, $y = 0.599 - 0.072x$, $p = 0.049$). Maximum fawn survival rates from 1995 to 1998 decrease sharply with increasing winter precipitation (dashed line, $y = 1.048 - 0.228x$, $p = 0.068$).

Sage Grouse. Numbers of active, inactive and unknown activity status sage grouse leks that have at least 1 oil or gas well within distances of 0.25 mile, 0.50 mile, 2 miles and 3 miles in each of two USGMAs are provided in Table II.E-5. It appears that, at least in USGMA 3, more than 3 times as many leks with at least 1 oil or gas well within a 0.50-mile radius are inactive than are active. Of leks with at least 1 well within a 0.25-mile radius, 4 times as many are inactive than active although numbers of each are small (Table II.E-5). More leks in USGMA 7 that have a well(s) within a 2-mile radius are active than inactive, but not so in USGMA 3. More leks in both USGMAs are active than inactive with nearest wells at distances between 2 and 3 miles away.

With any of the alternatives for proposed development on the PAPA, numbers of wells and miles of road would increase in both USGMAs within distances between 0.25 mile and 3 miles of leks but not within 0.25 mile since BLM would prohibit placement of well pads, roads and above-ground structures within 0.25 mile of active sage grouse leks. In addition, there are at least 2,305 oil or gas wells that could still be drilled in permitted project areas that overlap both USGMAs. Of these, 450 wells are likely to be drilled in the foreseeable future (Riley Ridge and Jonah II project areas) but locations relative to sage grouse leks are not known.

The data from USGMA 3 indicates that sage grouse leks with a well(s) within distances of 0.25 to 2 miles are more likely to be inactive than active but do not demonstrate a cause-and-effect relationship between well proximity and lek activity. Additional information, including when wells were constructed in relation to lek activity history and subsequent activity status, would be necessary to before drawing such a conclusion. Noise associated with nearby oil and gas developments and operations may adversely affect sage grouse reproduction by interfering with auditory stimuli during courtship but additional research will be needed before such impact is known with certainty.

Table II.E-5. Numbers of active, inactive and unknown activity status sage grouse leks that have at least 1 oil or gas well within the specified distances in 2 Upland and Small Game Management Areas (USGMA).

Upland and Small Game Management Area - Number	Known Lek Activity Status	Number of Sage Grouse Leks And Activity Status With at Least 1 Oil/Gas Well Within the Specified Distance			
		Within 0.25 mile	Within 0.50 mile	Within 2.0 mile	Within 3.0 mile
Sublette - USGMA 3	Active	2	5	19	34
	Inactive	8	17	25	27
	Unknown	1	4	8	13
Eden - USGMA 7	Active	0	1	14	27
	Inactive	1	2	5	13
	Unknown	1	1	7	18

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